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Special Panel on Teaching

Environmental Policy for Engineers and Natural Scientists: A teaching module

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Abstract

This paper presents and discusses a new course entitled “Environmental Policy for Engineers and Natural Scientists” that is currently being developed in the Department of Environmental Sciences of the Swiss Federal Institute of Technology. Its overarching goal is that students of the technical and natural sciences acquire skills for critically examining and assessing complex environmental policy issues and for expressing themselves clearly in writing and speech. The didactic concept of the course follows a blended learning approach and combines individual web-based studying with team-oriented learning. The students acquire core contents of environmental policy individually in webclasses and write a position paper on a specific topic. Their statements are moderated and used for further debate in seminar sessions. Finally, the students elaborate expert reports on a controversial environmental issue in teams. Contents and didactic concept of the course are developed in order to serve four key learning targets, which are: acquiring a sound knowledge of the basics of environmental policy; understanding areas of tension in environmental policy; analysing and assessing environmental policy processes; and strengthening analytical, conceptual and communicative skills for negotiation in environmental policy and for developing an expert opinion. The course responds to the challenge of communication and knowledge transfer between academic education, technical and natural sciences, and environmental policy in practice.

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1 Introduction

Between 2004 and 2006, a new course in environmental policy is being developed in the Department of Environmental Sciences, Swiss Federal Institute of Technology in Zurich (SFIT). The course aims at introducing and establishing environmental policy as one of the social sciences themes in the curriculum of the Bachelor of Science in Environmental Sciences. Its primary goal is to sensitise students of the natural and engineering sciences for environmental policy processes and to equip them with analytical means to strengthen policy-relevant capabilities in their specialised and often highly technical fields.

This paper starts with a brief overview of the curriculum of the B.Sc. in Environmental Sciences in order to position the course of environmental policy in the teaching environment. It then presents and discusses the course contents, objectives, teaching goals, and the didactic concept and concludes with the project's implications. This paper is written in the production phase of the course in environmental policy. It cannot provide empirical evidence of how this teaching project in environmental policy may contribute to integrating the social sciences in natural science and engineering curricula at University level teaching. However, this paper shall stimulate discussion among colleagues of problems such as how the complexity of environmental policy processes could be communicated most effectively to future engineers and natural scientists, or to what extent flexible and generalist knowledge of the characteristics of (environmental) policy processes is valued in an era of ever growing specialisation in the natural and technical sciences.

2 Environmental sciences at the Swiss Federal Institute of Technology

The environmental sciences diploma degree was established at SFIT in 1987, followed by the foundation of the Department of Environmental Sciences in 1990. With the implementation of the Bologna Reform, the curriculum was modified in 2003 to meet the requirements for Bachelor and Master degrees in Environmental Sciences. The main goal of the curriculum, however, stayed the same. According to the students' guide (Wasem, et al., 2004), studies in environmental sciences enlarge and strengthen knowledge and comprehension of the natural environment's functions and of the human interaction with the biotic and abiotic environment. Both the Bachelor and Master curricula put a lot of emphasis on integrating and complementing knowledge of the natural, social and technical sciences. Also communicative skills are considered an important asset.

The first two years of undergraduate studies are dedicated to the basics of natural sciences (chemistry, physics, biology, mathematics, earth sciences) with a share of 66%. They are complemented with introductory lectures in law and economics (13%). Additionally, the students attend lectures, practical courses and excursions in the fields of the atmosphere, hydrosphere, pedosphere, anthroposphere, and land use (21%). In the third year, each student starts to focus on one of the environmental systems in more detail. The specific studies have a share of 31% of the total curriculum in the third year. The rest is dedicated to lectures and individual work in other natural and social sciences, humanities and engineering (69%). The course in environmental policy is one of the optional topics in social sciences in the third year of the Bachelor curriculum (see Figure 1).

Environmental sciences students at SFIT have a tight schedule of up to 38 contact hours per week. The teaching is mostly performed in the didactic forms of lectures, practical

courses, tutorials and excursions. Additionally, essays are written in the social and technical sciences courses.

Overall, the Department of Environmental Sciences promotes the degrees in environmental sciences as unique interdisciplinary trainings with a strong qualification in communication and assessment of complex environmental issues.¹

First Study Year:								
Chemistry	Mathematics	Biology	Technical Solutions	Earth and Production	Economics Law	IT	Integrated practical course	
Second Study Year:								
Physics	Mathematics	Biology	Environmental Systems	Engineering	Additional natural science courses	Social science courses	IT	Integrated practical course
Third Study Year:								
Specific studies in one of the environmental systems		Natural sciences and engineering			Social sciences and humanities			
					ENVIRONMENTAL POLICY			

Figure 1: B.Sc. Curriculum in Environmental Sciences and allocation of environmental policy course. (Overall shares: natural sciences 62.8%, social sciences and humanities 13.3%, specific natural sciences and engineering courses 12.2%, specific environmental systems studies 11.7%)

3 A new course: environmental policy for engineers and natural scientists

Rationale

The course “Environmental policy for engineers and natural scientists” is a first step in the development of a systematic teaching focus on environmental policy in the Department of Environmental Sciences at SFIT. It builds on the introductory course in political sciences of the second study year and benefits from long-term teaching and research in forest and nature conservation policy of the Professorship Forest Policy and Forest Economics.

The course is primarily developed as an optional subject in the social sciences part of the B.Sc. curriculum. Its primary goal is sensitise students of the natural and technical sciences for environmental policy arenas. Moreover, it aims at strengthening inter- and transdisciplinary skills as well as improving the holistic understanding of environmental processes both in the natural and in the human systems. The course gives an introduction into the politics of environmental sciences. It provides the students with the basics in environmental policy and a basis for assessment and synthesis of how complex environmental problems are being discussed and addressed in the political system. The political science focus adopted shall enlarge the students’ awareness for different positions and perceptions in environmental policy debates. By putting an emphasis on

¹ See also http://www.env.ethz.ch/education/index_EN.

writing and speech, the course shall moreover strengthen skills for communicating complex environmental issues and building expert opinions. These skills are a precondition for successfully assuming the tasks as environmental experts, research scientists, or policy makers in the future.

Teaching objectives

The teaching objectives of the course lie on a continuum of the cognitive dimension of learning (Bloom, 1972) and range from basic knowledge acquirement to scientifically-based assessment of a problem (see Table 1).

Cognitive teaching objective levels		Description	Implementation verbs
6	Evaluation	Judgements can be made on whether specific criteria have been fulfilled or not	Judge, draw conclusions, measure
5	Synthesis	Components or elements can be assembled into a (new) whole	assemble, plan, design, define, draw up, formulate, arrange, combine, construct
4	Analysis	The facts of a case can be broken down into its constituent parts	(describe, correct and complete), take from, break down, investigate, structure, demonstrate, derive, cover, allocate, separate, identify, contrast, compare
3	Application	Rules and principles can be used in defined situations	(classify), calculate, (carry out), set up, develop, estimate
2	Comprehension	New information can be processed and assigned within a larger-scale context	describe, clarify, interpret, indicate, translate, make clear, justify, explain
1	Knowledge	Familiar information can be retrieved from memory	name, enumerate, write out, measure, represent, show

Table 1: Cognitive levels of learning (Schüpbach, et al., 2003, after Bloom 1972)

In the beginning of the course, the students shall acquire a basic knowledge of environmental policy and the politics of environmental sciences. Then, they shall demonstrate that they understood the learning contents by identifying different policy positions and options. In a next stage, they shall develop and negotiate their own and others' positions. Finally, they shall analyse and assess complex environmental policy issues from a policy analysis point of view.

Overall, the teaching objectives base on a constructivist understanding of learning (e.g. Plöger, 1999). It emphasises interaction and situated knowledge that is reflexive and flexible and goes beyond the recapitulation of specific teaching contents. Knowledge is acquired by individual (re)construction and dialogue. This understanding of learning supports cognitive flexibility and the awareness for multiple contexts and perspectives, as a key characteristic of (environmental) policy research. Therefore, the teaching objectives of this course are basically two-fold: They focus on acquiring individual expertise as well as communicative skills for using this knowledge in the analysis of complex environmental questions.

Didactic concept

In order to attain these teaching goals a specific didactic concept applies. It combines four didactic elements and is realised with a blended learning approach. Blended learning means the combination of new teaching technologies and e-learning with traditional forms of teaching (e.g. seminars) (Schüpbach, et al., 2003). Each of the four didactic elements has a different set of teaching objectives. They follow each other in a learning sequence and are linked with each other on a web-based learning platform. The four didactic concepts are the webclass, the position paper, the seminar, and the expert opinion (see Figure 2). The mode of learning ranges from independent and individual studying to learning in teams.

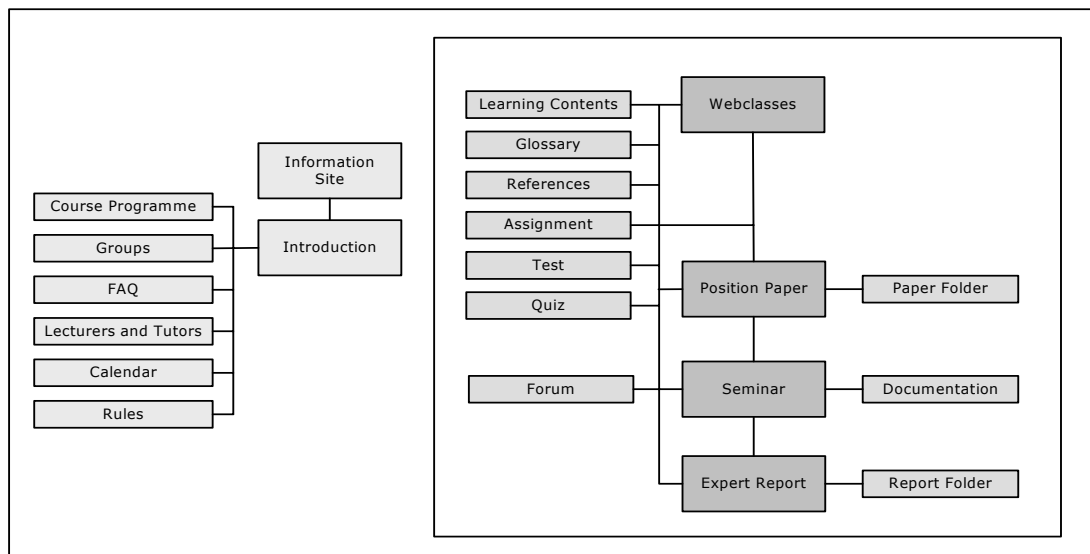


Figure 2: Schematic course organisation.

Webclasses

The webclasses impart the basics of environmental policy, grouped according to the four main topics “Introduction to environmental policy”, “Actors and institutions in environmental policy”, “Programmes and instrument types in environmental policy”, and “Environmental policy processes”. The teaching goal associated with this didactic element is primarily to build environmental policy knowledge (step 1 in Table 1). The webclasses are entirely realised by an e-learning approach that supports individual and web-based interactive learning. They are designed to raise enhanced interest in environmental policy topics and foster further individual studying by internet searches and enquiries based on specific questions. The students study individually, according to their own time budget and interests.

Open questions, tests and quizzes help to control the learning progress both by the students themselves and by the lecturers who follow up the students’ learning (step 2 in Table 1). The added value of the webclasses in environmental policy in comparison to a conventional text book is seen in the immediate combination of lecture notes, glossary, tests, and enquiry opportunities thanks to working on-line.

The webclasses are run on the OLAT server of the University of Zurich. OLAT stands for Online Learning and Training and is a software especially developed for University level e-learning and teaching.² Next to the web-based learning platform of the webclasses OLAT offers discussion and moderation opportunities for interactive work between students themselves and between students and lecturers/tutors. These features guarantee that learning progress can be monitored and that the achievement of teaching goals can be evaluated.

Position paper

Based on the basic theoretical issues and exemplary case studies provided in the webclasses the students subsequently write a position paper. As the name says, the students are asked to position themselves within a certain debate. The objective is that they argue on the basis of their acquired knowledge of environmental policy and that they formulate their individual ideas about the topic (steps 2 and 3 in Table 1). Moreover, they should inform themselves about the positions and interests of others vis-à-vis the specific case or question. The teaching goal of this didactic element is to make them think about complex contents in environmental policy as well as to sensitise them for their own view and for the position of others. This assignment is also a preparation for the next didactic element, the seminar. On the basis of the position paper the lecturer and tutors of the course establish roles for round table discussions and negotiation processes.

Seminars

The teaching goals of the seminar are to use environmental policy knowledge, to link it with natural science expertise and to communicate ideas and interests (steps 4 and 5 in Table 1). The students will negotiate their own and official positions in round table discussions. In the round table discussions, students play a number of different roles, representing voices from the environmental, social and economic realm. The spectrum of these roles range from environmental activists to opponents of environmental policy. The idea is to introduce them to the complexity of discussions that take place in political arenas. The mode of learning adopted in the seminar is learning in teams. Students shall identify norms and values in environmental policy debate, negotiate different perspectives and positions and suggest ways to resolve policy dilemmas of environmental problems. Contents of these simulated debates and stages of the policy process are selected cases of environmental policy, such as the formulation or implementation of legal guidelines for GMO crop cultivation or the construction of a new nuclear power plant. Environmental policy is hereby linked with the technical and natural science topics that the students of environmental sciences acquired in other courses and in-depth studies of environmental systems.

Expert report

In the sense of making a synthesis of complex environmental and policy issues the students finally elaborate an expert report in teams (steps 5 and 6 in Table 1). With the didactic element of the expert report the students should attain skills to thoroughly assess

² See also <http://www.olat.org>.

complex environmental policy issues and to communicate them in form of a written document. This report, in analogy to a policy brief, includes a short concise introduction to the politically controversially debated environmental policy issue (e.g. GMO, nuclear power) and provides an expert opinion elaborated in teams. This didactic element qualifies for scientific competence and expertise which require the synthesis, reduction and weighing of complex environmental questions to be tackled in environmental policy.

4 Conclusions

This paper presented and discussed a teaching project in environmental policy, currently being developed at the Swiss Federal Institute of Technology. Its aim is to build both environmental policy expertise as well as communicative skills among students of the natural and technical sciences. It adopts a constructivist learning approach that builds on interactive forms of learning and teaching. The project's implications are twofold. The development of the course "Environmental Policy for Engineers and Natural Scientists" does not only create a new teaching and learning environment for the students of environmental sciences at SFIT. It is also a new learning field for lecturers and tutors to rethink their modes of teaching and learning in the reform period towards the full implementation of the Bologna resolution. Despite many uncertainties in this reform period there is a great chance to reflect on past, present and future modes of learning and teaching in the (environmental sciences) curricula. A few open questions remain for the immediate future and the test phase of the course (spring term 2005). Is the course able to impart the complexity of environmental policy processes? Does it raise knowledge of environmental policy contents and explanation? Does it increase the awareness for policy arenas and will the students be more susceptible for multiple perspectives and contested policy interests?

Apart from the course contents themselves there are wider questions concerning the value given to integrative knowledge at the interface between social, natural and technical sciences and the rather generalist skills that are advanced by such a course. These questions certainly foster new learning processes also among experienced lecturers and professors and shall help clarifying professional scope and roles of environmental sciences alumni in society.

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